

# 802.11 Wireless Ethernet

(File: 802Wireless.wpd, Update 07/24/01)

## Synopsis:

Wireless LAN technology is mature in the form of IEEE standard 802.11b, which provides up to 11 Mbits/second @ 2.4 GHz. Hardware is readily available and prices have been falling steadily. There is even signs of wireless LANS outside of vertical markets.

Development efforts to increase data throughput are focused around 802.11a, which operates at 5 GHz and up to 54 Mbits/sec speeds. Standards confusion and problems involving security and quality-of-service are delaying 802.11a but expect major rollouts in 2002. Manufacturers have been tweaking the standards for some time and all is still not resolved. Many are concerned about the incompatible European standard "HyperLAN2" and the lack of interoperability between 802.11b and 802.11a devices.

Evidence suggests that 802.11b has at least three more strong years and bandwidth crowding may make it viable beyond that. Dual .11b/a chip sets are in the works and an amalgam standard called 802.11g is also being discussed.

## Summary Facts:

Paradigm: Ethernet technology made wireless

Web Sites: <http://stdsbbs.ieee.org/group/802/11>  
<Http://www.wlana.com>

Standards: IEEE 802.11b Wireless Ethernet, 1-11 Mbits/sec @ 2.4 GHz \*  
IEEE 802.11a Wireless Ethernet, 6-54 Mbits/sec @ 5 GHz  
IEEE 802.11g Wireless Ethernet, 21 Mbits/sec @ 2.4 GHz  
IEEE 802.11 Wireless Ethernet, 2 Mbits/sec @ 2.4 GHz

\* This is the dominate standard at present

Device Cost: \$200 for PC Card  
\$700 Access Point for servers

## 802.11b

Range: 300 meters  
Spectrum: 2400 to 2483.5 MHz in the U.S., unlicensed, ISM band

Output Power:	1 watt max
Technology:	Frequency hopping, spread-spectrum (FHSS) as well as direct-sequence transmissions. Employs Time Division Duplexing (TDD) Slow hop rate (2.5 hops/sec)
IR version:	The 802.11 standard also applies for 850 -950 nm Infrared links. Uses 16-value pulse-position modulation. Transmission rates of 1Mbits/sec and 2 Mbits/sec are supported. IR range is up to about 10 meters with office ceilings as reflectors.
Channels:	79 1-MHz channels
Modulation:	Frequency-Shift keying (FSK) Direct sequence system uses differential binary phase-shift keying (DBPSK modulation for 1Mbits/sec. Differential quadrature shift keying (DQPSK) is used for 2Mbits/sec.
Transmission rate:	802.11 = 2 Mbps -- allows 15 units in close proximity 802.11b = 11 Mbps B allows 4 units in close proximity, security? (Actual 802.11b throughput is more like 6 Mbps)
Date types:	Voice & Data supported.
I/O:	USB supported
Network Design:	Ethernet
Nodes:	Many ad hoc peer-to-peer networks possible
Interconnects:	Gateways possible
Security:	Wired equivalent privacy (WEP), a 40-bit seed key and RC4 encryption algorithm. Only data packet contents are encrypted. Secure registration and authentication also supported.
OS Support:	MS Windows, CE, Palm, LINUX, etc.
Multimedia	802.11 does not support high-density, real-time multimedia applications but can support voice.  A single wireless LAN can support up to four full-duplex, lone-quality voice channels (assuming use of a Point Control Function (PCF)).
RFI Issues	Bluetooth & 802.11b, cordless phones, & even microwave ovens

use same 2.4 GHz spectrum in ISM band. Interference may disrupt 802.11b, not visa versa because fast hop rate of Bluetooth. Adaptive hopping is being considered by FCC to prevent devices from hopping into used channels.

802.11 direct sequence high rate devices are very reliable in the presence of Bluetooth transmissions. (Non-hopping)

802.11a devices are expected to escape RFI problems in new uncrowded 5 MHz frequency.

FCC does not regulate ISM Band.

Standard	Data rate Mbits/s	Range (meters)	Freq (GHz)	Spec Status	Availability
802.11	2	300	2.4	1999	Now
802.11b	11	100	2.4	Late 1999	Now
802.11a	6-54	200	5	2001	2001
802.11g*	11	200	2.4	2002	2002
802.15 BT	<1	10	2.4	1999	2q00
HomeRF	1.6	50	2.4	01/99	2q00
HomeRF+	10	50	2.4	Not done	?
HyperLAN2	6-54	100	5.0	2002	2002

\* incomplete standard as of 7/24/01

Alternate Technologies

- Ethernet (CAT-5) B Dominant wired LAN technology
- Bluetooth B Designed for short range links
- Bluetooth2 B Future 10 Mbit/sec next generation Bluetooth
- HomeRF B Home LAN, May become compatible with Bluetooth, Low end version of 802.11
- HomePNA B Home LAN
- Powerline B Uses home power cabling
- DECT - Digital European Cordless Telecommunications
- ETSI BRAND HiperLAN1 B European version of 802.11b
- ETSI BRAND HiperLAN2 B European version of 802.11a

Interop: Manufacturer Interoperability is becoming a problem. There is no certified test suite to ensure compatibility. 802.11a and 802.11b

devices are not interoperable at present.

- Issues:
- QoS -- Quality of Service
  - Signal to noise standards over given range
  - Multipath-handling capability
  - Throughput
  - Backward compatibility
  - Fall back
  - Complexity
  - FCC Requirements
  - Interoperability confusion in the 802.11a standards process.

Error Rates      WLAN-PHY error rates are three orders of magnitude greater than wired LANs. Hence 802.11 retransmits unacknowledged frames. Retries cause unpredictable delays that often block retransmission of subsequent, queued frames.

Network Standard	IEEE 802.11b	IEEE 802.11a
Access Method	CSMA/CA, SSMA	CSMA/CA
Modulation	CCK (8 complex chip spreading)	64 QAM - OFDM 16 QAM - OFDM QPSK-OFDM BPSK-OFDM
Date Rate (Mbits/sec)	1, 2, 5.5, & 11 (22 proposed)	6, 9, 12, 18, 24, 36, 48, & 54
Frequency Band (MHz)	2,400 to 2483.5	5.150 to 5.250 5.725 to 5,625 5,250 to 5,350
Channelization	25-30 MHz spacing 3 channels	20 MHz channel spacing
Transmit Power (e.i.r.p.) mW = Milli Watts W = Watts	1,000 mW 100 mW 10 mW/MHz	5,150 to 5,250 MHz 10 mW/MHz 200 mW in 20 MHz channel  5,250 to 5,350 MHz 1 W 5,725 to 5,825 MHz 4 W
Reality	Existing	Future - Proposed

## **PRODUCTS & ISSUES:**

**Chip Sets** -- Ultimately the products come down to the underlying chipsets. Single chip and double chip devices are now available from several manufactures for 802.11b and 802.11a (sampling). Dual 802.11b/11a chips are also coming. Chipset prices are running around \$35 and there is little evidence of much pricing difference between 802.11b and 802.11a chips.

**802.11g** – This proposed standard variation offers 802.11b compatibility by operating at 2.4 GHz with data rates of 22 Mbits/sec. The idea is to improve interoperability. All details are still not worked out (7/01 eWeek). Details involving security and quality-of-service may also be addressed with this revision. Development of chip sets that can operate within the .11a and .11b standards may obsolete this effort before a standard can be achieved. Also cost of .11a hardware has dramatically dropped so there is probably no cost advantage of .11g (EET 7/23/01).

**HiperLAN2** -- The European competing standard is evolving quickly and may be the main competitor to 802.11a. In some ways the European standard is said to be superior to 802.11a. This is especially true in handling of quality-of-service and security features. It also has strong dynamic frequency selection and “transmit power control” features. There is also a 1394 convergence layer targeted to the home market. Apparently the downside is that the standards process is tedious (EET, 07/01).

**Standards merger** – Negotiations are also underway to merge the HiperLAN2 and 802.11a standards. That may be optimistic, but the development community is trying to avoid multiple competing standards. The IEEE 5-GHz Global Study Group is also studying interoperability solutions. (EET, 07/01)

**Propagation Concerns** – There is concern that 5 GHz transceivers have poor signal propagation characteristics relative to 2.45 GHz transceivers. Concerns focus on overall range and in-building operation. Various studies claim this is not the case and that propagation is more dependent on building design than frequency for frequencies between 1.7 to 6 GHz. (EET, 07/01)

**Products** -- The most common Wireless LAN transceiver is on a PCMCIA card and inserted into a laptop. Also several manufactures are now building transceivers into their laptops. Other devices include bus cards for desktop computers, built-in and piggyback PDA transceivers, barcode scanners and access point adapters which connect the wired LAN to the wireless LAN. Unlike Bluetooth devices, it has not been envisioned that this technology will be built into a wide variety of appliances. But who can say.

**Wireless ISP Access Points** -- These access points allow any wireless LAN device to connect into the Internet through an ISP. To date Wayport has installed access points at: Wyndham Hotels, Royal Sonesta in Boston, and the Dallas/Fort Worth Airport. MobileStar has deployed 802.11b & OpenAir Wireless at 340 sites which include hotels, airports, restaurants (EET, 04/01).

IBM is working with Starbucks to deploy 802.11b connections in 4,000 Starbucks coffee shops by the end of 2002. The primary purpose is to allow corporate users a means of allowing their workers easy access to company intranets (EET 04/01).

### **Market Forecast:**

- \$4.6 billion by 2005 for total enterprise wireless LANS. (Cahners 04/01).
- 95% of notebook PCs will be 802.11b-enabled by 2005 (Gartner).
- 802.11b penetration in the corporate LAN will reach 50% by the end of 2002. It is currently 20%. (Gartner).
- 802.11b is a very good alternative to a wired Ethernet LAN for small business if you look at wiring and other costs.

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File: 802wireless.doc  
Update: 07-2-01  
MWB